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# Testing for Materiality in Volatile Markets

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In securities litigation, cases sometimes hinge on whether information that was omitted or misstated was important to a reasonable investor. Financial experts are often then called upon to examine whether a news announcement that corrected information that was previously misrepresented had a material effect on the price of a company's stock. To address the issue of materiality, experts and courts often rely on event studies.[1] The results of these event studies are used to calculate inflation (the difference between the actual price and the price the stock would have traded at had there been no misrepresentations), which is then used to estimate damages suffered by purchasers of the stock. Inferences from an event study will be stronger when the period used to calculate the expected returns and expected volatility (the estimation period) and the period in which the alleged disclosure occurred (the disclosure period) are similar except for the release of news related to the alleged fraud.[2] In this paper, we show that the increase in overall market volatility in the wake of the 2008 credit crisis can cause the traditional event study methodology to be inaccurate. In particular, we show that use of the traditional methodology during a period of generally increased volatility may improperly yield a finding that an immaterial disclosure is statistically significant (i.e., a "false positive"). We propose several ways to increase the accuracy of an event study in periods of increased market volatility.

## Event study primer

A typical allegation in a securities shareholder class action is that a company failed to disclose negative information relevant to its investors. Plaintiffs will often allege that this information was made public at some point (the disclosure date) and caused the stock price drop. An event study is typically used to evaluate plaintiffs' claims.[3] The purpose of an event study is to measure the price movement of a security in response to new information. An event study is conceptually performed in two stages. First, a market model is created that predicts the returns of a stock based on the returns of a market index.[4] The market model separates the stock's returns into two parts: the portion of returns explained by the market index and the part attributable to company-specific factors. This latter portion, known as

the residual or abnormal return, includes any part of the return caused by factors unrelated to the general market movement such as firm-specific information released that day. The market model also provides a measure of the variability of the company-specific portion of the stock's returns, which is known as the standard error. Experts use this measure to assess the statistical significance of the price movement following a disclosure. Because statistical significance is a way of characterizing how unusual a result is, the more volatile the stock returns are estimated to be, the larger any price movement would have to be for it to be deemed statistically significant.[5]

In shareholder class actions, market models are often estimated over the year prior to the beginning of the class period, and thus do not directly measure the variability of the stock's returns during the disclosure period. Insofar as a stock's returns behave differently around the time of the disclosures than during the estimation period, the standard error of the market model may be an inaccurate measure of company-specific variability at the time of the disclosures. For cases with relatively brief class periods that coincide with stable securities markets, the assumption that the volatility has not changed substantially between the estimation and disclosure periods is more likely to be correct. For a case with a long class period that encompasses periods of market stability and periods of uncertain and tumultuous markets, traditional methods may have to be reconsidered.

## Recent years are marked by tumultuous markets

The period from mid-2008 to mid-2009 was one of the most volatile times in the modern history of the United States' stock market. The increase in volatility in the stock market is illustrated in Table 1. The average expected daily volatility (the average expected fluctuation in the returns) of the S&P 100 Index, remained stable from approximately 0.7% to 1% from mid-2003 to mid-2007. From mid-2007 to mid-2008, the volatility increased to 1.3%. Finally, from mid-2008 to mid-2009, the volatility reached 2.22%, almost triple the level during the relatively stable mid-2005 to mid-2007 period.

**Table 1**

| Period | Average Implied Volatility |
|---|---|
| 1 July 2003-30 June 2004 | 0.97% |
| 1 July 2004-30 June 2005 | 0.79% |
| 1 July 2005-30 June 2006 | 0.68% |
| 1 July 2006-30 June 2007 | 0.68% |
| 1 July 2007-30 June 2008 | 1.29% |
| 1 July 2008-30 June 2009 | 2.22% |

This increase in volatility was not confined to market, or "systemic," risk exhibited by the S&P 100. Firm-specific risk, as measured by the variability of company-specific returns, increased substantially among firms in the S&P 100. The effect was most pronounced in the financial sector, where the crisis started, but is evident among all firms. Table 2 summarizes results of an analysis conducted on the constituents of the S&P 100 Index, where the average company-specific volatility is calculated over all of the 100 companies which traded over the full period, as well as for a subset of the companies in financial and non-financial sectors.[6] The results are striking: the average volatility for the companies in the financial sector from mid-2008 to mid-2009 was over twice the average volatility as in the previous year, at more than 5.4%. This implies that even an average market-adjusted return in mid-2008 to mid-2009 for a financial company would be deemed statistically significant if compared to the average volatility in the mid-2007 to mid-2008 period.[7]

**Table 2**

| Period | Average Company-Specific Volatility | | |
|---|---|---|---|
| | All | Financial | Non-Financial |
| 1 July 2005-30 June 2006 | 1.18% | 0.84% | 1.22% |
| 1 July 2006-30 June 2007 | 1.14% | 0.82% | 1.19% |
| 1 July 2007-30 June 2008 | 1.51% | 1.88% | 1.46% |
| 1 July 2008-30 June 2009 | 2.69% | 5.42% | 2.30% |

As a consequence of this increase in volatility, the traditional event study methodology can prove inaccurate. The recent increase in volatility calls into question whether inferences from an event study using an estimation period from a few years back can be accepted without additional analysis: an estimation period from mid-2005 to mid-2007 (or earlier) paired with a later event period may yield inaccurate and unreliable results, given the striking increase in firm-specific volatility.

## The traditional event study methodology yields too many "statistically significant" days

To determine how problematic this increase in market volatility is for traditional event studies, we analyzed the constituents of the S&P 100 Index to determine how many days would exhibit statistically significant abnormal returns during three one-year periods (1 July 2006-30 June 2007, 1 July 2007-30 June 2008, and 1 July 2008-30 June 2009) when using the prior year as the estimation period.[8] If the estimation period and the disclosure period are similar, using the standard 5% significance level, there is a 5% chance that a day will be deemed statistically significant in the absence of material news. In other words, we expect 5% of tested days to have statistically significant returns if the baseline market model is accurate.[9] If the standard errors are based on a period when the stock was much less volatile, they will be too low and too many days will be identified as statistically significant. If we estimated standard errors based on a period when the stock was much more volatile, we would find that too few days are found to be statistically significant.

Because about 5% of the approximately 252 trading days in a year should be statistically significant at the 5% level by definition, the expected number of significant days for each of the three periods is about 12 days. The average number of significant dates over 97 securities summarized in Table 3 confirms our concerns about the standard methodology: it performs well in the 1 July 2006-30 June 2007 period, which is expected given that the volatilities in that period and the prior year were roughly the same. In contrast, in the 1 July 2007-30 June 2008 period and particularly in the 1 July 2008-30 June 2009 period, the standard methodology yields far too many "statistically significant" days on average for each company.

**Table 3**

| Period | Statistically Significant Dates | |
|---|---|---|
| | Number | Percent |
| 1 July 2006-30 June 2007 | 11.7 | 4.7% |
| 1 July 2007-30 June 2008 | 32.1 | 12.7% |
| 1 July 2008-30 June 2009 | 52.6 | 20.9% |

## Three possible solutions

### Move the estimation period forward to the event window

The simplest way to resolve the issues associated with performing an event study over a period of heightened volatility would be to use the disclosure period as the estimation period. One can "overlap" the estimation and the disclosure period, by construction guaranteeing similar volatilities between the two periods. The application of this approach, sometimes employed by plaintiffs' experts, is not necessarily free from bias. One must ensure that all disclosures and misrepresentations, as well as any other news associated with the fraud, are excluded from the estimation period in order to obtain a "clean" benchmark. Determining relevancy introduces subjectivity. Further, when the pattern of company-specific returns is alleged to be affected by the fraud even on days not directly associated with the release of news, using the company-specific data from the disclosure period may be objectionable.[10]

### Obtain a market expectation of volatility for disclosure dates

Another possibility is to use the market's expectation of daily volatility to measure statistical significance. Trading an option is essentially taking a bet on the volatility of the stock underlying it. Using the well-known Black-Scholes option-pricing formula, we can back out the market expectation of volatility from the market prices of traded options. An estimate of volatility based on a stock's option price is called *implied volatility*. Since implied volatility may rise on the day of an alleged disclosure, reflecting a rise in uncertainty regarding the company's prospects, implied volatility from the day before the event date can be used. However, unlike the standard error of a market model, implied volatilities measure the expected variability of the entire return of a stock or market index, not just the company-specific portion.[11] Although several experts have used the market expectation of volatility in their event studies, we propose an additional step: if we know how the stock price varies relative to the market index, we can compute the expected variability of the company-specific portion of the stock's returns using the implied volatilities of the stock and the market index. (This approach is described in more detail in the Appendix).

The application of this method may prove problematic for the same reasons as discussed for the prior method: when the pattern of company-specific returns is alleged to be affected by the fraud even on days not directly associated with the release of news, using company-specific data from the disclosure period may be objectionable.[12] In the following section, we describe a method not subject to this potential problem.

### Predict volatility for disclosure dates

For situations in which there is a concern that the prolonged revelation of the fraud has contaminated the implied volatility of the firm's stock, we propose predicting implied volatility that can be used to obtain clean event-specific standard errors. The key element to this method is that we estimate the firm-specific volatility by using the volatility of the market as a whole. This reflects the relationship documented above in connection with the heightened volatility in 2008-2009: when market volatility increases, firm-specific volatility seems also to increase. In this method, we estimate not only the market model, which relates the company's returns to market returns, but also a model that depicts the relationship between the company's volatility and the volatility of the market. The relationship between the volatilities in the estimation period is then used to predict the company-specific volatility in the disclosure period. The predicted company-specific implied volatility, unlike the market expectation of company-specific volatility, does not rely on the company-specific data from the event window.

There are some complexities involved in predicting company-specific volatility, as noted in academic empirical studies that analyze the volatility of broad markets as well as the idiosyncratic volatilty of individual stocks.[13] We use a statistical approach that allows us to predict the expected return and

company-specific volatility in the event window, which can then be used in the tests of statistical significance. The procedure we employ, described in the Appendix, has the advantage of not using any data that might be contaminated by disclosures during the event period.

## Empirical illustration

To illustrate the behavior of the proposed solutions, we selected 10 companies that were constituents of the S&P 500 Index and traded from 1 July 2004- 30 June 2009.[14] Using the standard methodology and two of the three proposed adjustments,[15] we calculate the number of "statistically significant" days for four periods (1 July 2005- 30 June 2006; 1 July 2006- 30 June 2007; 1 July 1, 2007- 30 June 2008; and 1 July 2008- 30 June 2009), using a period one year prior to the "disclosure" period as the estimation period. The average number of days found to be "statistically significant" for the three periods is summarized in Table 4.

**Table 4**

| | Number of "Statistically Significant" Dates Using | | |
|---|---|---|---|
| **Period** | **Standard Methodology** | **Market Expectation of the Company-Specific Volatility** | **Index-based Prediction of the Company-Specific Volatility** |
| 1 July 2005- 30 June 2006 | 11.8 (4.7%) | 7.7 (3.4%) | 15.8 (6.3%) |
| 1 July 2006- 30 June 2007 | 8.4 (3.4%) | 9.1 (3.7%) | 9.1 (3.6%) |
| 1 July 2007- 30 June 2008 | 38.7 (15.4%) | 21.6 (8.9%) | 20.0 (7.9%) |
| 1 July 2008- 30 June 2009 | 52.4 (20.8%) | 15.8 (6.3%) | 17.1 (6.8%) |

While the standard methodology provides reliable estimates of the number of the significant days in the periods of relatively stable volatility, it identifies too many "statistically significant" days in the recent period of increased volatility. Using the market expectation of the company-specific volatility reduces the number of significant dates substantially, and yields approximately the expected number of statistically significant dates over the periods examined.[16] The final adjustment, which does not require the use of company's implied volatility but only a volatility of a broad market index, also yields a significantly lower number of significant days compared to the use of the standard methodology during the recent volatile period.

It is worth noting that the choice and the application of the proposed adjustments for an actual case should be informed by the facts and circumstances of that case. For example, in some instances it may be prudent to use industry controls either alone or together with a broad market index.

## Summary

We argue that in times when there has been a large change in volatility, the use of the event-specific market expectation of the company-specific volatility and index-based prediction of the company-specific volatility yield more reasonable estimates of stock price inflation, and thus damages, than traditional methods. In support of this argument, we find that traditional methods of assessing statistical significance result in an implausibly high number of statistically significant days during the event period characterized by generally increased volatility.

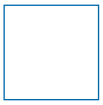
# Appendix

## Market prediction of volatility for disclosure dates

Estimation of the expectation of company-specific volatility consists of two steps. In the first, we estimate a market model, which establishes how the company's returns vary with the returns of a market index:

$$R_t^A = \alpha + \beta R_t^M + \varepsilon_t, \quad (1)$$

where $R_t^A$ is a return of Company A on day t, $R_t^M$ is a return of the broad market index on day $t$, $\alpha$ is a constant term that depicts the trend that would be observed in the company's returns if the market were flat, $\beta$ is a coefficient capturing how the stock returns vary relative to the market index and $\varepsilon_t$ is an error term that depicts the movement of the stock's returns that cannot be explained by the movement in a market index (which is referred to above as the company-specific portion of the stock's return).



In the second step, using $\beta$ from the market model in (1), we calculate the expectation of the company-specific volatility using the following formula:

$$Vol_{company\text{-}specific} = \sqrt{Vol^2_{company\text{-}total} - \beta^2 Vol^2_{market}}, \quad (2)$$

where $Vol_{company\text{-}specific}$ is the market expectation of the company-specific volatility, $Vol_{company\text{-}total}$ is the company's implied volatility, and $Vol_{market}$ is the implied volatility of the market index.

## Predict volatility for disclosure dates

Suppose we are interested in assessing if a disclosure by Company A was associated with a statistically significant return. A simple approach is to first estimate a market model (1) over the estimation period. Then, over the same period, we estimate a relationship between the company's total implied volatility, and the implied volatility of the market index:

$$totVol^2\ (A)_t = a + bVol^2\ (M)_t + e_t, \quad (3)$$

where $totVol^2\ (A)_t$ is the total implied volatility of Company A expressed as a variance rather than the standard deviation, $Vol^2(M)$ is the square of the implied volatility of the market index, $a$ is a coefficient depicting the trend in Company A's total volatility, $b$ is a coefficient capturing how Company A's total implied volatility varies relative to the implied volatility of the market index, and $e_t$ is an error term depicting the variation in Company A's total volatility that cannot be explained by the variation of the implied volatility of the market index.

For each date in the event window, we can calculate Company A's specific (idiosyncratic) implied volatility using the following formula:

$$predVol(A)_t = \sqrt{\hat{a} + \left(\hat{b} - \hat{\beta}^2\right) Vol^2\ (M)_t}, \quad (4)$$

where $predVol(A)_t$ is the predicted company-specific (idiosyncratic) implied volatility for Company A and $Vol(M)_t$ is the implied volatility of the market index, and $\hat{\beta}$, $\hat{a}$ and $\hat{b}$ are estimated coefficients from the models described in (1) and (3).

Unfortunately, this simple approach does not guarantee that the predicted (total) implied volatility is positive. In equation (3), the negative relationship between the implied volatilities may cause the predicted (total) volatility for Company A to be negative. Further, the relationship between the estimated coefficients in equations (1) and (3) may be such that the predicted idiosyncatic volatility is not a real number.[17]

An alternative to the simple approach described above is to model the company-specific, or idionsyncratic, volatility more explicitly. In one possible specification, the error term in the market model described in (1) can be allowed to depend on the implied volatility of a broad market index.[18] The idiosyncratic volatility can then be estimated using a generalized autoregressive conditional heteroscedasticity model. This model may be used to predict the company-specific (idiosyncratic) volatility of Company A for the days in the event window. This method is particularly useful in instances where the implied volatility data for the company of interest is not available.

## End notes

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1 See for instance *In re Executive Telecard Ltd. Securities Litigation*, 979 F.Supp. 1021 (S.D.N.Y. 1997) and *In re Imperial Credit Industries, Inc. Securities Litigation*, 2003 WL 1563084 (C.D.Cal. 2003).

2 For simplicity's sake we will hereafter drop the alleged modifier from "alleged disclosure" and "alleged fraud" etc.

3 Event studies are a form of a classic statistical experiment: a treatment is applied to a group (the treatment group), and the outcome is compared with the outcome of the group that did not receive a treatment (the control group). If the difference between the two outcomes is found to be statistically significantly different from zero, the treatment is considered to have caused an effect. See for instance Fama, Eugene F., Jensen, Michael C., Fisher, Lawrence, and Roll, Richard W., "The Adjustment of Stock Prices to New Information," *International Economic Review*, 10(1969)1-21.

4 Market models can be used for securities other than stocks and can contain, for example, an industry index in addition to or in place of a broad market index. They can also be used to analyze a group of securities rather than just a single security.

5 In other words, the larger the standard error of the market model, the greater the abnormal return will have to be to be considered statistically significant, or different from what we would expect to see in the absence of material news.

6 The analysis examines firms in the S&P100 as of 2 March 2009. Three firms were excluded because they did not trade over the full period. Twelve of the remaining 97 firms are classified as being in the financial sector by Bloomberg's "level I classification… [which is] based on [the firm's] business or economic function and characteristics."

7 In particular, the standard error of 5.42% is roughly equal to the typical market-adjusted movement for financial companies from mid-2008 to mid-2009. The ratio of this figure to the 1.88% from the prior year equals 2.88, well above the level of 1.96 needed to show statistical significance at the 5% level.

8 In an event study, the standard test of statistical significance asks the following question: what is the probability of observing an excess return at least this large in the absence of material news? Informally, it assesses how different or unusual the return was on the event day.

9 More technically, because there is firm-related news on days in both the estimation period and the period in which we test dates for statistical significance, we would expect only 5% of the days in the testing period to be statistically significant if the proportion of news dates was unchanged (i.e., there was not a new source of material news in the event period such as one or more corrective disclosures.)

[10] Imagine, for example, that a company announces on Monday that its previous SEC filings are no longer reliable, and is uncertain when it will file amended forms. If the amended forms are filed on Friday, it is relatively clear that Monday and Friday should be excluded from the estimation window. However, any news about the company released Tuesday through Thursday would presumably take on heightened importance to investors relative to if the company's books had been reliable. Therefore, the uncertainty regarding the company's financials may affect the volatility of its stock even on days where no news directly related to the SEC forms was issued.

[11] Again, the company-specific portion of a stock's return is the part of the return that cannot be explained by market factors. See above, p. 2.

[12] Suppose a company announces on Monday that it will make an important disclosure the following Friday, but does not specify if this disclosure is positive or negative. As a consequence of this announcement, the implied volatility increases, reflecting the uncertainty regarding the nature of the announced disclosure. This increase in implied volatility may lead to a finding that the disclosure was not statistically significant, even though the announcement was material.

[13] See for instance John Y. Campbell, Lettau Martin, Malkiel Burton, Xu Yexiao, "Replication data for: Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk," *The Journal of Finance* 46(2001)1-43; Spiegel, Matthew I. and Wang, Xiaotong, "Cross-sectional Variation in Stock Returns: Liquidity and Idiosyncratic Risk," *Yale ICF Working Paper No. 05-13*, 8 September 2005; Wagner, Niklas F., "Time-Varying Moments, Idiosyncratic Risk, and an Application to Hot-Issue IPO Aftermarket Returns," *Research in International Business and Finance* 18(2004)59-72; and Xu, Yexiao and Malkiel, Burton G. G., "Investigating the Behavior of Idiosyncratic Volatility," *Journal of Business* 76(2003)613-44. Chok, Jay Inghwee and Sun, Qian, "Determinants of Idiosyncratic Volatility for Biotech IPO Firms," USC Marshall School of Business Research Paper; *Financial Management*, 2007.

[14] We use a list of companies constituting the S&P 500 Index on 2 March 2009 sorted in the alphabetical order after removing the companies that were in the S&P100 and select every 40th company. If a company did not have actively traded options or was a defendant in class action suit, that company was not included in the sample. We excluded one company based on these two criteria (Textron Inc, which is a defendant in a class action suit), and included instead the next company in the alphabetic ordering (Thermo Fisher Scientific Inc).

[15] To properly use the first proposed adjustment and overlap the estimation and event periods, all relevant news dates need to be identified and excluded from the estimation. Due to the extensive amount of work this would entail, we did not implement that analysis for the purposes of this paper.

[16] Calculation of market expectation of the company-specific volatility requires that the data on that company's implied volatility be available. For several companies in our sample, the implied volatility data were not available for all days during the relevant periods, which may cause a downward bias in the number of significant days (it is plausible that the day for which the implied volatility is not available is a significant day). The reported percentage of significant days is calculated based on the number of trading days for which the company implied volatility data was available.

[17] To ensure that the predicted volatility for Company A is positive, the relationship described in equation (3) can be established between the logarithms of the two implied volatilities. In this case, the equations (3) and (4) become

$$\ln(totVol(A)_t) = c + d\ln(Vol(M)_t) + \mu_t \qquad (5)$$

and

$$predVol(A)_t = \sqrt{e^{(\hat{c}+\hat{d}\ln(Vol(M)_t))} - \hat{\beta}^2 Vol^2(M)_t} \qquad (6)$$

However, even though the log-log specification in (5) ensures that the predicted (total) implied volatility is positive, it does not ensure that the predicted idiosyncratic volatility, described in (6) is real (i.e., that the expression under the square root is positive).

[18] In this model, the error term is no longer assumed to have a constant variance.

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